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(54) A method of removing mold deposits and a cleaning composition for use therein

(57) The invention consists of a method for removing deposits from the surface of a mold for making a thermoplastic resin product, with the aid of a cleaning liquid, in which the cleaning liquid is an organic cleaning liquid containing a lactone compound, and optionally in addition one or more of an alcohol, water, or an organic solvent. The lactone may be α-angelica lactone, β-propiolactone, γ-butyrolactone, γ-caprylolactone, γ-laurolactone, γ-palmitolactone, γ-stearolactone, crotolactone γ-valerolactone, δ-valerolactone, γ-caprolactone and δ-caprolactone, and may be admixed with one or both of water or an organic solvent, e.g. alcohols.

SPECIFICATION

A method of removing mold deposits and a cleansing composition for use therein

This invention relates to a mold-deposit cleaning method using a liquid which permits easy removal of mold deposits formed on the surface of a mold during the molding of a thermoplastic resin composition.

The molding of a thermoplastic resin composition is usually carried out by injection molding or extrusion. One trouble experienced in connection with such operations is that gases developed during the operation become solidified, or compounds contained in the composition separate out, so that they deposit on the surface of the mold. Such deposits are likely to transfer on to the surface parts of the molding, i.e. the molded product, so that they often impair the appearance or dimensional accuracy of molded products; or they cause sticking of the molded product in the mold.

Various attempts have been made in order to remove such mold deposits, but no satisfactory method has yet been found. Methods in general use at present include a method such that a cleaning liquid is applied to the mold and then the deposits are wiped off with cloth or absorbent wadding. According to another method, after a cleaning liquid is applied, molding operations are carried out under normal molding conditions, and then the deposits are removed. However, the known cleaning liquids have insufficient cleaning quality, and more especially where such deposits as paraformaldehyde are involved, as in the case of molding a polyacetal composition, the known liquids are not very effective.

If a solvent containing a strong alkaline or acidic, or oxidising component is used, deposit removal may be performed fairly easily, but such solvent is unsuitable for use, because it is likely to cause corrosion or damage to the mold surface.

Moreover, wiping work involves considerable labour; and in the case of a complex mold, such as one used in precision molding for a toothed wheel or the like, it is difficult thoroughly to remove the deposits present in detail portions; and sometimes the mold may be damaged during wiping work.

Therefore, extensive researches have been made in order to find a cleaning liquid capable of effectively removing mold deposits, and the present invention has as its object to provide a viable and in most cases advantageous alternative to the cleaning liquids and methods known in the art.

Accordingly, in a method for removing unwanted deposits from the surface of a mold for a thermoplastic resin with a cleaning liquid, the invention provides an improvement in that the said cleaning liquid is an organic cleaning liquid containing therein a lactone compound.

The invention further provides a cleaning liquid composition for the use defined above which composition comprises 5 to 50 wt. % of a lactone, 5 to 95 wt. % of an alcohol and the balance of water or an organic solvent.

In other words, the invention relates to a method of removing from a mold deposits of a thermoplastic resin composition, such as for example a polyacetal resin composition, which method comprises using an organic cleaning liquid containing lactones and, more particularly, lactones and alcohols.

The lactones herein, which are essential components of the cleaning liquid used in this invention, are cyclic esters containing a functional group of ester —CO—O— in their rings, and derivatives thereof, that is, substances in which the number of atoms constituting a main ring including an ester group is 4–6, or β-lactone (4–member ring), γ-lactone (5-member ring), and δ-lactone (6-member ring), and their derivatives. Examples of these substances are α-angelica lactone, β-propiolactone, β-angelicalactone, γ-butyrolactone, γ-caprylolactone, γ-laurolactone, γ-palmitolactone, γ-stearolactone, crotolactone, γ-valerolactone, δ-valerolactone, γ-caprolactone, and δ-caprolactone.

The amount of lactones used in the invention is at least 5% by weight or more, preferably 10–50% by weight, relative to the cleaning liquid as a whole.

Such lactones may be used mixed with other organic solvents. Most suitable for use as such other organic solvents are alcohols. The alcohols herein referred to may be monohydric, dihydric, and polyhydric alcohols, both saturated and unsaturated, or aliphatic and aromatic hydrocarbons, alicyclic compounds and the like. Preferred saturated aliphatic monohydric and dihydric alcohols, in their alkyl groups, have 1–6 carbon atoms, more preferably 1–4 carbon atoms. Examples of these alcohols are methanol, ethanol, propyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, sec-butyl alcohol, tert-butyl alcohol, ethylene glycol, propylene glycol, trimethylene glycol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 2,3-butanediol, and isobutylene glycol. Examples of alcohols of aromatic compounds are benzyl alcohol and cinnamyl alcohol. Examples of alicyclic alcohols are cyclopentanol and cyclohexanol.

Further, the lactones may be used in the form of a mixed liquid containing one or more kinds of other solvents, such as water, ethers, ketones, other esters, aromatic hydrocarbons, or other

halogen derivatives. The cleaning liquid is effective especially where it contains both lactones and alcohols, in which case the proportion of alcohols is 5–95% by weight, preferably 50–90% by weight, relative to the cleaning liquid as a whole.

To remove mold deposits by using the cleaning liquid according to the invention, any known procedure in general practice may be employed. For example, the deposits present on the mold may be wiped off with a piece of cloth, paper, or the like moistened with the cleaning liquid of the invention (in which connection some suitable polishing powder may be used in combination with the liquid); or the cleaning liquid is applied to the mold surface on which deposits are present, and then molding is repeated to transfer the deposits on to the molded part so that the deposits may be removed from the mold surface; or above said both procedures may be used in combination. In any other removal procedure, the cleaning liquid of the invention may be effectively used as well.

The method of removing mold deposits by using the organic cleaning liquid containing lactones in accordance with the invention involves no possibility of corrosion or damage being caused to the mold and permits easier removal of deposits, as compared with the conventional method in which ordinary organic solvents containing no lactone, such as alcohols, ethers, ketones, other esters, water, or a mixture of two or more kinds of them, are used. For example, where deposits on the mold surface are wiped off with a piece of cloth moistened with the cleaning liquid, the number of wiping times required until the original clean surface is restored can be reduced; or where the liquid is applied on the mold deposits and then molding is repeated to transfer the deposits on to the mold for deposit removal, the number of molding cycles and time required can be reduced. Generally, removal of mold deposits according to the conventional method can be made easier the higher the mold temperature is, but increasing the mold temperature involves longer interruptions of production molding operations, so that production efficiency is affected. However, according to the method of the invention in which the cleaning liquid of the invention is used, mold deposits can be removed even if the mold temperature is relatively low; therefore, the method of the invention is advantageous in terms of production efficiency as well.

The following examples are given to further illustrate the invention; however, it is understood that the invention is not limited by these examples.

Examples 1–7, and Comparative Examples 1–10:–

Ten thousand shots of circular moldings (50 mmP×3 mm) were molded from a polyacetal resin, Duracon M 9002 produced by Polyplastics Co., by injection molding under conditions of resin temperature 200°C and mold temperature 60°C, and it was found that a white mold deposit was present on an insert in the mold. The insert was then removed, and with no particular heating, wipe-off tests were made using 5 cm square pieces of cloth (flannel) evenly wetted respectively with the cleaning liquids shown in Table 1, and fourfolded. Tests were made in such a way that every one-time wiping operation was carried out under same conditions as far as possible (that is, the mold surface was wiped twice with same piece of cloth—which was counted as one time—and same operation was repeated by changing the cloth each time), and comparison was made with respect to the number of wiping times required until the mold surface was restored to its original clean condition in terms of luster or the like factor (Method A). The results are shown in Table 1, under Method-A column.

Besides the foregoing, molding was carried out under same conditions as above, and with respect to the post-molding mold on which similar deposits were present, cleaning tests were made, without removing the insert and with no particular heating, by applying one of the cleaning liquids shown in Table 1 on to the mold deposit for each test, and carrying out molding operation one minute thereafter, which procedures were repeated until the mold surface was restored to its original clean condition in terms of luster or the like factor. In this process of testing, the cleaning liquid was applied anew every five shots (Method-B). The results are shown in Table 1, under Method-B column.

Examples 8–9, and Comparative Examples 11–14:–

Injection molding was carried out using a polyacetal resin, Tenac-4010 produced by Asahi Chemical Industry Co., Ltd., and under slightly modified molding conditions (resin temperture 210°C, mold temperatures 80°C). Tests were made by using the cleaning liquids shown in Table 2 and in exactly the same manner as in the foregoing Examples and Comparative Examples. The results are shown in Table 2.

Examples 10–11, and Comparative Examples 15–17:–

Twenty thousand shots of circular moldings (50 mm diameter×3 mm) were molded from a flame retardant polyester resin. Duraned 3370 produced by Polyplastics Co., by injection molding under conditions of resin temperature 250°C and mold temperature 60°C, and it was found that a white mold deposit was present on the mold surface, with some tarry deposit outside the cavity. With no particular heating of the mold, wipe-off tests were made in manner similar to Method A in Examples 1–7. The results are shown in Table 3.

Table 1

Test No.		Cleaning Liquid ( ) : wt %	Method A (No. of wiping times required in restoring original condition)	Method B (No. of shots required in restoring original condition)
Example	1	γ-butyrolactone (10) - isopropyl alcohol (90)	6	10
	2	γ-butyrolactone (30) - isopropyl alcohol (70)	4	7
	3	γ-caprolactone (30) - isopropyl alcohol (70)	5	8
	4	γ-butyrolactone (30) - butanol (70)	5	8
	5	γ-butyrolactone (30) - bengyl alcohol (70)	5	7
	6	γ-butyrolactone (30) - trichloroethylene (70)	7	12
	7	γ-butyrolactone (30) - ethyl acetate (70)	8	12
Comparative Example	1	isopropyl alcohol (100)	20	>20 (not completely restored)
	2	butanol (100)	>20 (not completely restored)	>20 (not completely restored)
	3	benzene (100)	>20 (not completely restored)	>20 (not completely restored)
	4	benzyl alcohol (100)	>20 (not completely restored)	>20 (not completely restored)
	5	ethyl acetate (100)	>20 (not completely restored)	>20 (not completely restored)
	6	trichloroethylene (100)	20	20
	7	isopropyl alcohol (70) - butanol (30)	20	>20 (not completely restored)
	8	isopropyl alcohol (70) - benzyl alcohol (30)	10	14
	9	isopropyl alcohol (70) - ethyl acetate (30)	>20 (not compeltely restored)	>20 (not completely restored)
	10	isopropyl alcohol (70) - trichloroethylene (30)	15	16

Table 2

Test No.		Cleaning Liquid ( ) : wt %	Method A (No. of wiping times required in restoring original condition)	Method B (No. of shots required in restoring original condition)
Example	8	γ-butyrolactone (30) - isopropyl alcohol (70)	5	8
	9	γ-butyrolactone (30) - benzyl alcohol (70)	5	7
Comp. Example	11	isopropyl alcohol (100)	>20 (not completely restored)	>20 (not completely restored)
	12	trichloroethylene (100)	>20 (not completely restored)	>20 (not completely restored)
	13	isopropyl alcohol (70) - benzyl alcohol (30)	8	12
	14	isopropyl alcohol (70) - trichloroethylene (30)	16	18

Table 3

Test No.		Cleaning Liquid ( ) : wt %	Method A (No. of wiping times required in restoring original condition)
Example	10	γ-butyrolactone (30) - isopropyl alcohol (70)	3
	11	γ-butyrolactone (30) - methylethyl ketone (70)	3
Comp. Example	15	isopropyl alcohol (100)	8
	16	methylethyl ketone (100)	8
	17	benzene (100)	10

CLAIMS

1. A method for removing from the surface of a mold deposits of a thermoplastic resin, the method comprising the use of a cleaning liquid, and wherein said cleaning liquid is an organic cleaning liquid incorporating a lactone or derivative thereof.

2. A method as claimed in Claim 1, in which said cleaning liquid comprises an alcohol and a lactone.

3. A method as claimed in Claim 1, in which said thermoplastic resin is a polyacetal.

4. A method as claimed in Claim 1, in which said cleaning liquid comprises 5% to 50 wt. % of a lactone, 5% to 95 wt. % of an alcohol and optionally, in addition, one or both of water, or an organic solvent.

5. A cleaning liquid for use in the middle defined in claim 1, and wherein said cleaning liquid is an organic cleaning liquid incorporating a lactone or derivative thereof.

6. A liquid according to claim 5 wherein, said liquid includes one or more of cyclic esters containing a functional group of ester —CO—O— in their rings, and derivatives thereof, that is, substances in which the number of atoms constituting a main ring including an ester group is 4–6, or β-lactone (4-member ring), γ-lactone (5-member ring), and δ-lactone (6 member ring), and their derivatives such as; α-angelica lactone, β-propiolactone, β-angelicalactone, γ-butyrolactone, γ-caprylolactone, γ-laurolactone, γ-palmitolactone, γ-stearolactone, crotolactone, γ-valerolactone, δ-valerolactone, γ-caprolactone, and δ-caprolactone.

7. A cleaning liquid for use in the method defined in claim 1, and substantially as hereinbefore described.

8. A method for removing from the surface of a mold deposits of a thermoplastic resin, according to claim 1, and substantially as hereinbefore described.

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